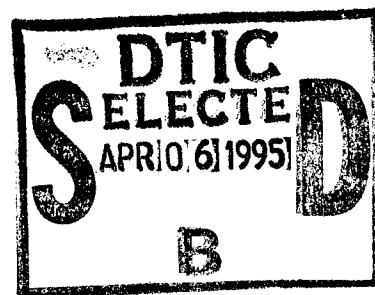


# AOARD REPORT

The Laboratory for International Fuzzy Engineering Research

Mar 11, 94  
T. Davis  
AOARD



A review of the organization, objectives and research activities of the Laboratory for International Fuzzy Engineering Research (LIFE), sponsored by the Ministry of Trade and Industry and located in Yokohama, Japan, is presented. This review is based upon information collected from published brochures and an 11 March, 1994 visit to the laboratory. The visit was hosted by Dr. Toshiro Terano, Senior Managing Director (Research) and Dr. Anca Luminita Ralescu, Assistant Director of the Laboratory, and in addition to a background brief on the laboratory organization and objectives included a series of fuzzy logic project presentations.

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# The Laboratory for International Fuzzy Engineering Research

## Abstract

A review of the organization, objectives and research activities of the Laboratory for International Fuzzy Engineering Research (LIFE), sponsored by the Ministry of Trade and Industry and located in Yokohama, Japan, is presented. This review is based upon information collected from published brochures and an 11 March, 1994 visit to the laboratory. The visit was hosted by Dr. Toshiro Terano, Senior Managing Director (Research) and Dr. Anca Luminita Ralescu, Assistant Director of the Laboratory, and in addition to a background brief on the laboratory organization and objectives included a series of fuzzy logic project presentations.

## 1. Laboratory Background, Organization and Objectives

The Laboratory for International Fuzzy Engineering Research (LIFE) was founded in Yokohama, Japan on 28 March, 1989 at the direction of the Minister of International Trade and Industry, in accordance with provisions of the National Research and Development Program. Its charter extends for a period of six years, and is scheduled to end on 31 March, 1995 at the conclusion of the Japanese fiscal year 1994. The Chairman of its Board of Directors is Mr. Fumio Sato, President of TOSHIBA CORP. Dr. Toshiro Terano is the Senior Managing Director (Research) and Dr. Anca Luminita Ralescu is the Assistant Director of the Laboratory. Contact information for Drs. Terano and Ralescu is as follows:

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LIFE is a joint Japanese government/industry activity, organized as a consortium of about fifty members. The Japanese government is represented in the consortium by the Ministry of Trade and Industry. The composition of the list of industrial sponsors varies from time to time. A current list is included in section 3 below.

The Japanese government's contribution to LIFE's budget is about \$50M for the six year project duration and about \$9M for the current fiscal year (FY94). The industrial sponsors provide the majority of the research staff, which is

composed of about 30 full time researchers. Of that number, about 25 are employed by industrial sponsors and the remainder are visiting foreign nationals. Some of the visiting researchers are supported by LIFE via fellowships and some by their respective foreign employers. Currently, visiting researchers from France, Spain, China, Ireland and the U.S. are in residence at LIFE.

The stated objective of LIFE is "...to vitalize the basic study of fuzzy theory and the research on its efficient utilization by strengthening ties between industrial and academic circles, and to promote international technological exchange". Section 2 below is a summary of the research program by which LIFE intends to achieve its stated objective.

Current indications are that the Japanese government will establish a follow on fuzzy logic research program to replace LIFE after its charter expires at the end of March in 1995. However, beyond some speculation about the follow on program name, POST LIFE, very little information about it is available at this time.

## **2. LIFE's Fuzzy Logic Research Program**

The research program at LIFE is currently assembled around five distinct fuzzy logic project areas. The project areas are, along with a two or three letter project acronym, Fuzzy Computing (FC), Intelligent Interface (IF), Fuzzy Associative Memory (FAM), Image Understanding (IU) and Sophisticated Intelligent Robots (ROB). Each is summarized briefly in the following paragraphs.

The Fuzzy Computing (FC) project area is staffed by five full time researchers. Its primary theme is natural language processing, and it is an attempt to exploit the ability of fuzzy logic to deal with the ambiguity inherent in natural languages. One of the key research results claimed by the Fuzzy Computing project team is a generalized modus ponens. The FC project area results are fundamental to and used by several of the other project areas.

The Intelligent Interface (IF) project area, which occupies two full time researchers, attempts to construct a system for enhancing the exchange of information between people and computers, i.e. an advanced human-computer interface. The aim is to create a decision support system which is more cooperative and closer to a human advisor than a conventional expert system, in terms of both interaction and problem solving. A rental property search scenario is employed as a concrete example problem. This project area is the fuzzy logic variant of the human interface development thrust which is currently receiving a great deal of attention in Japanese research circles.

The Fuzzy Associative Memory (FAM) project area employs three full time researchers. It attempts to combine the ability of fuzzy logic to represent vague concepts and the ability of neural networks to deduce relationships in order to create a new knowledge representation and processing paradigm. The new paradigm features automatic acquisition of vague knowledge and fuzzy rules via a two way association between physical quantities and abstract concepts. The project includes a human interface example problem in which the human operator's facial expressions and control actions are automatically associated by the interface agent.

The Image Understanding (IU) project area employs a variable number of full time researchers with between ten and fifteen being typical. The IU results are fundamental to the other projects and Dr. Ralescu is the senior researcher responsible for the project. A stated aim of the IU project area is to achieve object recognition at a level comparable to the human ability. To achieve this aim, the project area is organized around three key research themes: (1) recognition of natural objects, using a fuzzy logic approach to deal with the inherent ambiguity, (2) recognition of the spatial organization of an image, with fuzzy logic methods employed in knowledge representation and (3) natural language representation of recognition results.

The Sophisticated Intelligent Robots (ROB) project encompasses two distinct projects, one titled Cooperative Work by Multiple Robots and a second called Fuzzy Control of a Semi-Autonomous Unmanned Helicopter. The aim of the former is to create a distributed robot system which "lives" with humans. The example problem employed by this project is a cooperative desk rearrangement problem using an action based inference system and a fuzzy action plan. This project is staffed by two full time researchers.

The Fuzzy Control of a Semi-Autonomous Unmanned Helicopter project is supported by and administered from LIFE but the principal researcher is Professor M. Sugeno from the Tokyo Institute of Technology. The goal of the project is an oral instruction tele-control system for remote operation of an unmanned helicopter. Numerous applications for such a control system can be imagined (e.g. sea rescue, mountain rescue, fire fighting and traffic surveillance to name a few). A demonstration testbed, assembled from off the shelf hardware, currently exists and has been successfully test flown.

### **3. Industrial Sponsors**

As noted above, LIFE is sponsored by a government/industry consortium. The Japanese government representative is the Ministry of Trade and Industry. Following is a current list of industrial sponsors.

CANON, INC.  
EBARA RESEARCH Co., Ltd.  
Fuji Electric Co., Ltd.  
FUJI HEAVY INDUSTRIES LTD.  
Fuji Research Institute Corporation  
FUJITSU LIMITED  
Fuji Xerox Co., Ltd.  
Hitachi, Ltd.  
HONDA R&D CO., LTD.  
IBM Japan, Ltd.  
INTEC Inc.  
Japan Aviation Electronics Industry, Ltd.  
Japan Electronic Computer Co., Ltd.  
KAO Corporation  
KAWASAKI STEEL CORPORATION  
KAYABA INDUSTRY CO., LTD.  
KOBE STEEL, LTD.  
KONICA CORPORATION  
MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.  
Mazda Motor Corporation

MEIDENSHA CORPORATION  
MEITEC CORPORATION  
Minolta Camera Co., Ltd.  
MITSUBISHI ELECTRIC CORPORATION  
MITSUBISHI KASEI CORPORATION  
NEC Corporation  
NIPPON STEEL CORPORATION  
NISSAN MOTOR CO., LTD.  
NKK Corporation  
N. T. T. Data Communications Systems Corporation  
Oki Electric Industry Co., Ltd.  
Olympus Optical Co., Ltd.  
OMRON Corporation  
RICOH COMPANY, LTD.  
SHARP CORPORATION  
SONY CORPORATION  
SUMITOMO ELECTRIC INDUSTRIES, LTD.  
TAKENAKA CORPORATION  
THOMPSON C.S.F. Japan  
TOKYO ELECTRIC POWER COMPANY  
TOSHIBA CORPORATION  
TOYOTA MOTOR CORPORATION  
Volkswagen AG.  
Yamatake Honeywell Co., Ltd.  
YAZAKI CORPORATION  
Yokogawa Electric Corporation